ever may be added, however, should be carefully selected, having regard to modern conditions. Very little additional matter will be taken from Euclid. We think the book would have been improved by a chapter on the solution of right-angled triangles, using the trigonometrical tables given at the end of the volume, results obtained graphically being verified by calculation. In subsequent work graphical and numerical computation would go on side by side. There are calculations relating to right-angled triangles quite as important as that of Euc. i. 47, and the drawing class seems to be the proper place in which to teach them to beginners. What better examples than the trigonometrical functions are to be found of ratio and proportion? Consider what a satisfaction it must be to a boy to find himself in possession of and familiar with this powerful modern weapon. And, moreover, the knowledge gained is of the utmost importance. In connection with this part of the subject, the radian measure of an angle should not be neglected; it is very desirable that a student should be trained so as to be able to think in radians as well as in right angles and degrees.

Next, a course seems very incomplete without some notion of projection, and how lengths and angles in three dimensional space are measured and represented. Following the author's plan, the principles of Euclid xi. would be inculcated along with exercises in descriptive geometry, involving quantitative measurement. This can be rendered quite interesting.

And lastly, one of the most fruitful additions that could possibly be made would be to introduce the idea of a vector, giving the triangle or parallelogram law, with some of its consequences. Geometry is essentially a vector subject, and an early knowledge of vectors would have far-reaching effects.

In the "Geometry" by Mr. S. O. Andrew we have another text-book in which exercises in drawing and deductive reasoning are carried on together, so that the student acquires some practical acquaintance with the subject-matter. But the work is not based sufficiently on accurate quantitative measurement, and the author seems satisfied with drawing of an inferior quality. We find no description of what sort of scales are suitable for measuring lengths. There is no information as to the manner of using and testing straight edges and squares. In the absence of any guidance to the contrary, the student is sure to use soft blunt pencils. There are no numerical answers given to any of the exercises.

But a teacher using the book could, to some extent, supply these omissions, and would find the volume very serviceable; it is the result of practical teaching experience. It covers substantially the same ground as the book previously considered, with a chapter on solid geometry and orthographic projection. Loci and graphs are introduced, and trigonometrical tables are given and explained, but are made very little use of in the text.

The text-books of Messrs. Allcock, Baker and Bourne, Lachlan and Fletcher, and Petch are alike in having for their main object the development of a system of formal geometry on Euclidean lines. The changes they introduce with the object of improving geometrical teaching are such alterations as the revision of the definitions and axioms, the rearrangement and regrouping of the propositions, the employment of arithmetic, algebra, loci, &c. Euclid's *form* of reasoning has in all cases been retained. Experimental geometry is not made prominent; it is brought in rather in connection with the examples which follow the propositions.

As it appears to us, these books are not sufficiently free of the Euclidean tradition to make them suitable for boys at school. They are more fitted for subsequent study. The presentation of the substance of Euclid i. by Allcock is excellent, and may well replace Euclid when the time comes for taking up the philosophy of the subject. In the volumes by Messrs. Baker and Bourne there is an introductory chapter on experimental geometry, extending over twenty pages, comprised of nearly two hundred exercises, ranging over the whole subject up to the end of Euclid vi., and intended to make the student practically acquainted with the ground to be subsequently covered. This chapter is a valuable and extremely suggestive one, so far as it goes; if the material had been set out in greater detail, and worked in along with the deductive geometry and accorded equal importance with the latter, a geometry quite suitable for youths would have been the result. As text-books of formal geometry these manuals by Messrs. Baker and Bourne can be strongly recommended. They cover the ground usually studied, including Euclid xi., and there are chapters on graphs and mensuration formulæ. They are beautifully printed and arranged, and contain many practical exercises.

Mr. Deakin's Euclid is written on strictly orthodox lines; it contains some useful notes and exercises by the author. The only evidence of any influence of the reform movement is at the end of Euclid vi., where an abstract is given of the recommendations of the committee of the Mathematical Association of 1902.

The little book on "Graphical Algebra" by Mr. Hall is intended to accompany the well-known "Elementary Algebra" of Messrs. Hall and Knight. It is concerned with graphs and squared-paper work, and illustrates some part of the service which geometry is rendering to algebra. Some of the examples are evidently taken from previous publications, though the author forgets to acknowledge their source.

J. Harrison.

SYSTEMATIC PETROGRAPHY.

Quantitative Classification of Igneous Rocks Based on Chemical and Mineral Characters, with a Systematic Nomenclature. By Whitman Cross, Joseph P. Iddings, Louis V. Pirsson, and Henry S. Washington, with an Introductory Review of the Development of Systematic Petrography in the Nineteenth Century, by Whitman Cross. Pp. x + 286. (Chicago: the University of Chicago Press; London: Wm. Wesley and Co., 1903.) Price 8*s.* net.

BY the very first page this book is defined as dealing with "the science of petrography." Petrology is "the broad science or treatise of rocks"; petrography is "the descriptive, systematic science, leading to the nomenclature of these objects." This elevation of systematic description to the rank of a science disarms a certain amount of criticism. The able authors, who confront us after a long period of careful thought and collaboration, take their stand here as petrographers, with all the dignity of a well marshalled mediæval "battle." Right and left we may read the blazon on their shields; their pages trumpet forth the titles by which they would be known; they stand for system and for order, for a "hierarchical classification" (p. 3), against a hitherto careless and indifferent world.

If the four champions are, for the time, not petrologists, but petrographers, still more strongly do they stand apart from the geologists. We have usually regarded rocks, and the lessons to be learned from them, as coming within the scope of the geologist. Just as the mineralogist begins with molecular aggregates, so the geologist begins with mineral aggregates, and from them seeks to read the history of the world. No such agreeable considerations are to be tolerated in the science of petrography. Our authors, some of whom, at least, have long been welcomed as geologists, have entered the field under sober vows of self-denial. The object of the petrographer (p. 63) is "to secure logical excellence for his system."

We are truly grateful for Mr. Cross's term "hierarchical." It seems to define the situation, and to add zest to the devious paths of heresy in which most of us at present wander. We even foresee that the petrologists—not the petrographers—will in the future be divided into two schools, those who desire a classification and those who would rather be without it. For the first school, there is much salvation in the present treatise; it will, indeed, give them as logical a classification as the imperfect human mind can conveniently grasp. As such, it has been welcomed by Mr. F. D. Adams in the pages of *Science* (February 27, 1903).

The reader, in mere fairness, must consider the principles of any classification independently of its nomenclature. The first proposition here made is (p. 128) to divide igneous rocks into five "classes," according to the minerals which might have crystallised, under certain conditions, from the magma represented by the chemical analysis of the rock. On the one hand we regard the group of minerals, quartz, felspars, felspathoids, zircon and corundum; on the other the group pyroxenes, olivine, magnetite, hæmatite, &c., in fact, broadly speaking, the ferromagnesian group (p. 116). The five classes are simply established according to the numerical predominance of one group or the other.

Each of the two mineral groups is divisible into two subgroups; in the first three classes of rocks, the silica-alumina group of minerals is of such importance that five "subclasses" may be based on the relative proportion of the two subgroups within this group in each particular rock. Similarly, the two subgroups of minerals of the ferromagnesian group are utilised to establish five subclasses of rocks inside classes iv. and v. (p. 130).

We may now pass on to "orders." One mineral subgroup in each subclass of rocks predominates over the other subgroup; on this basis we obtain orders of rocks, of which there are as many as nine in each of the first three subclasses of each of the first three classes (p. 132). Orders, with equally strict logic, may be divided into "sections."

So far, the possible minerals have given a position to the rock. We may, however, consider the "general character of the bases in the minerals of the preponderant group in each class," which enables us to assign a "rang" to the same rock. Rangs are so absorbing that we confess to some annoyance when we come on p. 141 to "grads," which look like another exercise in subclasses, a matter that we have already taken carefully to heart. "Subgrads," a further division, need not be discussed in the present brief review.

Suddenly it flashes upon us that we have all this time been dealing with a possible but wholly imaginary object, and not with the rock which we have plucked, after miles of travel, from its parent mountain-side. Let not this thought obtain the mastery; it is a temptation of the evil one, whom we may call Lossen, or Judd, or Rosenbusch—for even the last-named author is now classed with the geologists. The rock, for hierarchical purposes, has both a body and a soul; the former (p. 147) is its "mode," or actual mineral composition; the latter is its "norm," or standard mineral composition, as obtained by calculation. Some species, of saintly character, have modes coincident with their norms; where this is not the case, the difference demands investigation.

Herein clearly lies the great value of precision in petrography, such as our authors introduce. The definite statement of the facts is obviously of first importance, before we seek to explain the deviation of mode from norm by experimental or observational geology. In such a statement, geological considerations are out of place; geological conditions have controlled the mode, but should not influence the name and rank assigned to the resulting product in a system of pure petrography. If we very properly reject geological age as a factor in rock-classification, so it is equally desirable to reject such groupings as "plutonic," "dyke-rocks" and "volcanic." Pp. 149 to 153 of the present book go far indeed to justify the precision of its system.

When, however, we come to part ii., on nomenclature, we prefer to leave the reader to go forward by himself. Every science must have its technical phraseology, and Mr. Bather justly objects[1] to the replacement of *Rhinellus furcatus* by "the fork-tailed Nosey." Yet those who multiply technical terms, and especially technical adjectives, forget that even the most specialised of specialists is not dealing with each term once a day; nor is he forced to describe a natural object as if a railway-whistle had sounded which summoned him for ever from the scene. May not scientific workers take heart, and gain grace, from the cultured descriptions of pictures in an ordinary well conducted catalogue? What are rocks but pictures, recording the most varied incidents in the history of the ground beneath us? The canvas was prepared of old time, but the design first traced upon it has been modified again and again by natural agents; new pigments have been absorbed by it, while others have changed their nature, and have often become more beautiful and permanent in their decay. The describer of a rock, the petrographer, may well pause before it, and proceed to fill in the details with an almost affectionate care.

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[1] See the *Museums Journal*, vol. ii, p. 138.

Is life, in fact, so brief that the name assigned to each object must express it completely in its habit as it lived?

We have no right to raise objections to the scheme of these four serious and conscientious workers, on the ground that it involves a considerable tax upon the memory. Yet we may question the advantage of compressing all our information into the tabloid form, and leaving the reader to dissect the compound in order to find out its contents. Abbreviation goes far when a rock, already accepted as *dosalane* in class, that is, with *s*ilica-*al*umina minerals pre*do*minant in its norm, is also found to be *grano-hornblende-germanare.*[1] In the scheme proposed, there is special virtue in the last syllables of such words. Yet what would be gained for the correct appreciation of a work of art if it were described as *samsodelic angelo-italare,* because it contained (or might in other circumstances have contained) Samson and Delilah, and belonged to the Italian school of which Michael Angelo is the representative? Or should we describe the House of Commons for 1903 as *unanim-hibern-britannare*, and also as *dochamberlane*, on account of the predominance of a particular constituent? "Is't not possible to understand in another tongue?"

Were we to comment on all the details selected as a basis for rock-classification, we should unduly extend the present notice. The historic review is of great interest and value, and the proposal (p. 180) to revert, for field-purposes, to the old loose signification of granite, diorite, &c., has some points in its favour. Similar reasoning, however, would allow us to speak of a mineral as a fossil; nor are the historic authorities always correctly invoked by the reformers of petrography. D'Aubuisson, that is to say, Haüy, from whom he had the term, does not (p. 182) use aphanite in the wide sense stated; for him, it is a compact diorite, with amphibole predominant over felspar. If we loosen the bonds of peridotite (p. 183), we must go back to Cordier, and use it for a basalt or dolerite rich in olivine. As for felsite (p. 184), the authors can hardly have realised the odd mixture of materials associated under the name by Gerhard. It may be sufficient to mention labradorite felspar and the pitchstone of Meissen as felsitic rocks in the sense of the inventor of the term.

However, we conclude as we began; there are persons who desire classification in order to promote accuracy of comparison. Such accuracy must be welcomed by every geologist, where individual specimens are concerned. Whether it is of so much service when we consider rock-masses as portions of the earth's crust is a question for the worker in this or that particular district. At any rate, our authors have sought perfection in the domain on which they set their gaze. To all of us is the mission sent, of Sir Persalane, Sir Salfemane, Sir Dofemane, and Sir Perfemane—for we cannot but regard these names (p. 102) as those of champions seeking for a Grail. The path is lit by their high endeavour, even if we may not follow it to the end.

Grenville A. J. Cole.

ALTERNATING CURRENT ENGINEERING.

Die Grundgesetze der Wechselstromtechnik. By Dr. Gustav Benischke. Pp. 141. (Brunswick: Friedrich Vieweg und Sohn, 1903.) Price 3.60 marks.

THIS volume, the third issue of "Elektrotechnik in Einzel-Darstellungen," comes as rather a surprise after the first two highly specialised parts of this series on lightning arrestors and the parallel running of alternators. In order to peruse the book with profit, the reader must be acquainted with the fundamental theory of electricity and magnetism, and also with the general laws of electrical engineering. Ability to use the differential and integral calculus is also necessary, in order to understand the mathematical reasoning given.

The book is divided into six parts—introduction, the simple alternating current circuit, mutual induction, capacity phenomena, composite wave forms, and polyphase currents. The arrangement and scope of the book will render it of most use to the practical electrical engineer, who, though using certain symbols and equations every day, yet is apt to lose sight of their fundamental origin, and, in order to comprehend new problems, needs, now and then, to refresh himself in the theoretical basis of his work. Such a simple thing as the measured value of an alternating current is an example of what we mean. Every engineer knows, of course, that what he calls the current is the root of the mean of the squares of the instantaneous values of the current. Why this should be, and to prove the reason why, would, we think, puzzle a good many men who would be very much insulted if they were told that they could not do so. The why and the wherefore of this matter is set forth in the introduction of the book. Part ii. deals chiefly with the application of Ohm's law to the alternating current circuit, the work done by an alternating current and the use of vectors. The third and largest part of the book is concerned mostly with the laws of the transformer. No attempt to treat of design is made, nor is the practical performance of any actual machines studied. The subject is treated purely from the theoretical engineering point of view.

Part iv., on capacity, is very short, and does not give much beyond the deduction of the formula for the calculation of the effective current in a circuit containing resistance, self-induction and capacity, and also showing the conditions under which electrical resonance can occur. Part v. is the most useful of the book, as it serves as a guide to the difficult task of dealing with the irregular wave-forms given by alternators and transformers. The appendix can be used in con-

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[1] Mr. H. Stanley-Jevons (*Geological Magazine*, 1901, p. 313) has already attempted such terms as *Sodali-midalkalite* and *Ægiaugi-natrijolite*. It would of course be similarly possible to express a whole chemical analysis by a skilfully constructed word some decimetres in length.